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TEST OF SHELTERS, ACCORDION-TYPE, SMALL

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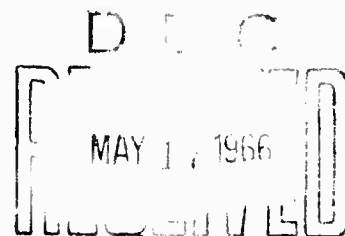
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## SUMMARY PAGE

### THE PROBLEM

To evaluate a small-size, accordion-type, frame shelter.

### FINDINGS

That in its present design the test item can serve as an aid station or dental office but that it is not sufficiently durable for use in forward combat areas.

### RECOMMENDATIONS

It is recommended that the deficiencies listed in Annex C of this report be corrected before the test item is considered for adoption as a standard item.

## ADMINISTRATIVE INFORMATION

This evaluation was conducted at the request of the Marine Corps Landing Force Development Center, Quantico, Virginia.

Bureau of Medicine and Surgery, Navy Department, work unit MF022.03.04-8006. Final report. Approved for publication 11 April 1966.

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Project No. : 42-61-01A

Subject: Test of Shelters, Accordion-Type, Small: final report

Reference: (a) MCLFDC test procedure 46/3D/AES:kd  
42-61-01A of 1 April 1965 (Project No. 42-61-01A)

Annexes: A. Military characteristics for medium extendible shelter  
B. Photographs of shelter, accordion-type, small  
C. Deficiencies found in shelter, accordion-type, small, and suggested modifications

I. Introduction:

By means of reference (a), the Marine Corps Landing Force Development Center requested that a small accordion-type shelter be furnished to and tested by the Naval Medical Field Research Laboratory (NMFRL) to determine the following:

A. Ventilation characteristics of the shelter.

B. Optimum number and type of standard Marine Corps heaters required to sufficiently heat the shelter.

C. Whether the materials used in the construction of the shelter are toxic or contain elements which will cause dermatitis or seriously complicate wounds.

D. Suitability of the test shelter for employment by FMF medical and dental units.

E. Methods to be used, material to be utilized, and the degree to which the shelter can be insectproofed.

The shelter is one of the results of efforts of the Marine Corps Landing Force Development Center to develop field shelters which can fill a multitude of operational requirements, yet which will be a substantial improvement over various types of shelters presently used within the FMF. Basic design consideration emphasized (a) minimum number of components, (b) maximum component interchangeability, (c) maximum flexibility and utility. Using this design approach, it was judged that this new design configuration of shelters could be used as a vehicle

for evaluation of several new types of lightweight cover material, some of which have not previously been tested for military tentage requirements.

The shelter furnished to NMFRL for evaluation is of a size suitable for employment as aid stations, dental offices, command posts, fire direction centers, ordnance maintenance shelters, communication/electronics maintenance, communication centers, and similar installations in forward areas under field conditions. The ideal characteristics of a shelter intended for these purposes are similar to those contained in Annex A.

The test item was subjected to the following procedures to achieve the purposes of the test:

A. Subjected to weather at Camp Lejeune, North Carolina for a period of ten months.

B. Checked for effects on personnel by using samples of fabric from it and from standard canvas tents for skin patch tests and for injection under the skin of animals to determine reaction.

C. Studied to determine field methods of insectproofing it.

D. Used by the Physiology Division, NMFRL, both in the field and in garrison.

E. Scrutinized by FMF medical personnel stationed at Camp Lejeune.

F. Examined by members of the Advisory Committee on FMF Medical and Dental Materiel Allowances.

G. Tested to determine ventilation, heating, and cooling characteristics.

H. Measured to determine dimensions, cube, and weight.

I. Erected, dismantled, and transported to determine time required for and problems encountered in erecting, striking and transporting it.

The test item, illustrated in Annex B, consists of a small, semi-cylindrical, accordion-type, extendible shelter and a zippered packing case made from coated fabric. The shelter consists of an aluminum

frame with a suspended, 4-ounce per square yard nylon cover. When extended, the shelter measures 8 feet high, 8 feet wide, and 20 feet long. When packed for transport, it measures approximately 8 feet by 2-1/3 feet by 1 foot and weighs 171 pounds. Auxiliary lightweight fabric connectors can be used for fastening the shelter and like shelters end to end, thus increasing their utility.

The shelter is equipped with four screened windows, two on each side of the shelter. The windows are closed by means of attached flaps and Velcro fasteners. The ends of the shelter are closed by means of a flap and two heavy-duty zippers, one on either side of the flap. Anchoring is accomplished by means of 12 guy lines and 12 ground stakes.

## II. Results of tests:

A. Although the test item was erected and exposed for 10 months to the climatic conditions occurring at Camp Lejeune, North Carolina, no major deficiencies were noted in the nylon cover. However, one of the framework brace bars was broken during one of the shelter striking operations. Several minor deficiencies were noted which are listed and discussed in Annex C. Notwithstanding the minor deficiencies, the shelter performed sufficiently well to justify the conclusion that the test item will provide a trouble-free, low-maintenance, permanent-type shelter for periods longer than one year providing it is not subjected to repeated erecting, striking, and transporting.

B. Samples of fabric from the test item and from standard tents were applied to the backs of five subjects using standard patch test technique. Seventy-two hours later the patches were removed and the previously covered areas were carefully examined by a physician. Little evidence of dermatitis was observed and, if anything, the canvas caused more irritation than the fabric from the test item. Samples of the fabric from the test item and standard canvas tents were ground finely and placed both under the skin and in the muscle tissue of white rats. The rats were sacrificed and dissected three weeks later. No evidence of toxic reaction was found; all samples were encapsulated. It is concluded that the fabric of the test item does not contain elements which would cause dermatitis or seriously complicate wounds and that, in this respect, the fabric may be somewhat safer than the canvas used in standard tents.

C. The test item is so designed that it can be easily insect-proofed by suspending fabric screens at each end of the fabric cover. However, this will probably be required only in hot weather when it is

desirable to have the ends of the shelter open for increased air flow. The present window screens are adequate for moderate weather.

D. The test item was used for various purposes while undergoing test at NMFRL. Among these was its use for conducting physical examinations in the field by the Physiology Division, NMFRL. Furthermore, the item was inspected by members of the Advisory Committee on FMF Medical and Dental Materiel Allowances and also by medical and dental officers stationed at Camp Lejeune. The general feeling among personnel who tested and/or inspected the test item is that one or preferably two would make a satisfactory battalion aid station shelter providing the framework was more durable and the cover material made light-proof and that one would be adequate for a two-chair field dental facility. Also, because of its design, which facilitates rapid setting up and striking, the test item has an advantage over the standard M-1945 Command Post Tent for forward area use. However, the M-1945 Command Post Tent will withstand this type of use better than the test item because it is more simple and not so easily damaged.

E. The test item can be adequately ventilated and cooled by opening and/or closing one or more of the four windows and one or both ends of the shelter as necessary. However, the item cannot be adequately ventilated under blackout conditions unless its design is modified to include forced ventilation.

F. The efficacy of heating the test item was determined by utilizing one space heater (FSN 5420-257-4877). The space heater was installed approximately 2 feet from one end flap and approximately 3 feet from each side of the shelter. The flue was run through a hole made in the roof just above the heater; oil was supplied to the heater from a supply can located outside the shelter. A thermometer was placed in the center of the shelter, 12 feet from the heater and 3 feet above the ground. Temperature both inside and outside of the shelter at the start of the test was 20°F. After the heater was ignited, 35 minutes were required for the thermometer to reach 70°F. and 50 minutes to reach 88°F. The outside temperature remained at 20°F. throughout the test. These results indicate that the test item can be adequately heated by utilizing only one standard space heater.

G. Other observations made during the use of the test item are as follows: The test item is lighter, has fewer loose parts, and requires less time and fewer men to erect and strike than the standard M-1945 Command Post Tent. With a crew of only two men, the test item can be erected in 13 minutes, including driving the ground stakes and

securing the guy lines. Also, only 10 minutes are required for a two-man crew to strike the shelter and secure it in its carrying case.

H. As a means of consolidating the results of the test, and comparing the shelter with a currently standard shelter of similar size, the opinions of test personnel with regard to certain characteristics of the test item and the standard M-1945 Command Post Tent are summarized and tabulated as follows:

Characteristic	Test Item: Superior	Standard M-1945 Command Post Tent: Superior	Test Item & Standard M-1945 Command Post Tent: Equivalent
Cube			X
Weight	X		
Packing & transportation	X		
Training of personnel			X
Erection & striking	X		
Anchoring	X		
Camouflage			X
Blackout integrity		X	
Watertight integrity			X
Repair			X
Entrance suitability		X	
Interior color & secondary illumination			X
Heating (basis is unit volume)			X
Cooling (basis is number of windows & vents)			X
Ventilation (basis is number windows & vents)			X
Simplicity			X
Durability (fwd. area use)		X	
Semi-permanent use	X		
Reliability			X



### III. Rating of test item versus desired military characteristics:

Next, the characteristics of the test item were reviewed using the desired military characteristics (Annex A) as a guide. Since the test item met the desired characteristics in many respects, only its deviations from these characteristics are noted below.

a. The test item will not provide suitable shelter under world-wide environmental conditions unless it is modified to include insulation, air-conditioning equipment, and heating equipment.

b. The material from which the test item was constructed is not light-proof. Therefore, it cannot be utilized where blackout integrity is required.

c. Ventilation is not adequate when the test item is closed for blackout conditions.

d. The test item does not provide maximum achievable protection from thermal radiation or cold. This could be corrected to some extent by use of an insulated liner.

e. The test item does not have instructional material permanently affixed indicating the proper methods of erection, use, maintenance, etc.

f. The test item is not extendible in height. It has a fixed height of 8 feet.

g. The test item does not have a repair kit.

h. In almost all other respects, the test item seems to comply with the desired military characteristics.

### IV. General conclusions:

It is concluded (1) that in its present design the test item can be used in rear support areas where it would not be moved frequently but not in forward combat areas; (2) that the fabric is not suitable for combat use because it is translucent and, consequently, does not have blackout integrity; and (3) that the hardware and framing is not sufficiently durable for forward area use.

V. Recommendations:

It is recommended that the deficiencies listed in Annex C be corrected before the test item is considered for adoption as a standard item. It is further recommended that the present standard tentage be retained for use in forward area combat zones until better shelters which are logistically satisfactory become available.

## ANNEX A

### DESIRED MILITARY CHARACTERISTICS

The characteristics which were used as a guide to the development of the medium extendible shelter and which are pertinent to the evaluation of the finished product are listed below:

1. Be capable of withstanding, under field conditions, ambient temperatures ranging from  $-25^{\circ}\text{F.}$  to  $+125^{\circ}\text{F.}$
2. Be capable of storage for not less than three years at temperatures ranging from  $-65^{\circ}\text{F.}$  to  $+155^{\circ}\text{F.}$  without deterioration.
3. Provide portable shelter under world-wide environmental conditions to protect personnel, supplies, vehicles, and other equipment from rain, dust, heat, and cold.
4. Be capable of expanding into a larger shelter by addition of component sections.
5. Be constructed of material sufficiently light proof to preclude detection of lights of sufficient candle power to permit detailed work within the shelter when such lights are suspended from the center portion of the shelter and viewed from outside at a distance of 50 feet during darkness.
6. Be so designed the persons wearing arctic uniforms and handwear can erect and transport this shelter.
7. Include provisions for use of suitable heating devices.
8. Provide adequate ventilation under all conditions with emphasis on blackout.
9. Provide adequate means for a control of ventilation.
10. Give protection, remain upright, and not be reduced materially in inside dimensions as a result of the effects of winds up to 45 knots with gusts up to 65 knots.
11. Be capable of being anchored in soil or natural surface that may be encountered in anticipated areas of use without an excessive number of attachments or modifications to the primary anchoring means.

12. Be so constructed that both inside space and openings will not be obstructed by poles or framework.

13. Be so constructed that inside wall covering shall be resistant to such substances as fuels and lubricants.

14. Be so constructed that support shall be lightweight and collapsible.

15. Be capable of being erected over a stalled or disabled vehicle.

16. Be capable of being erected by four men using no special tools or equipment.

17. Be capable of being erected and struck in as short a period of time as possible, but in no event should they require more time than the present types utilized.

18. The basic shelters will be of such size as not to exceed 4,000 cubic feet in volume.

19. The basic shelter will be of such shape and such design as to render maximum utilization of interior space.

20. The basic shelter shall weigh a minimum consistent with other essential characteristics and probable handling facilities and transportation means.

21. Be completely waterproof when erected.

22. Be capable of transport in vehicles organic to the using unit.

23. Be capable of being portaged by four men for short distances.

24. The basic shelter shall have a life expectancy in use of a minimum of one year of normal use.

25. The basic shelter in storage shall have a minimum of three years of open or covered storage life when packed for shipment to the field.

26. Be constructed of materials resistant to mildew, erosion, fuels and lubricants, wind and fire, and proof against fungus, water and insect damage.

27. Be compatible with current camouflage practices. Provide maximal achievable protection from thermal radiation consistent with other characteristics.

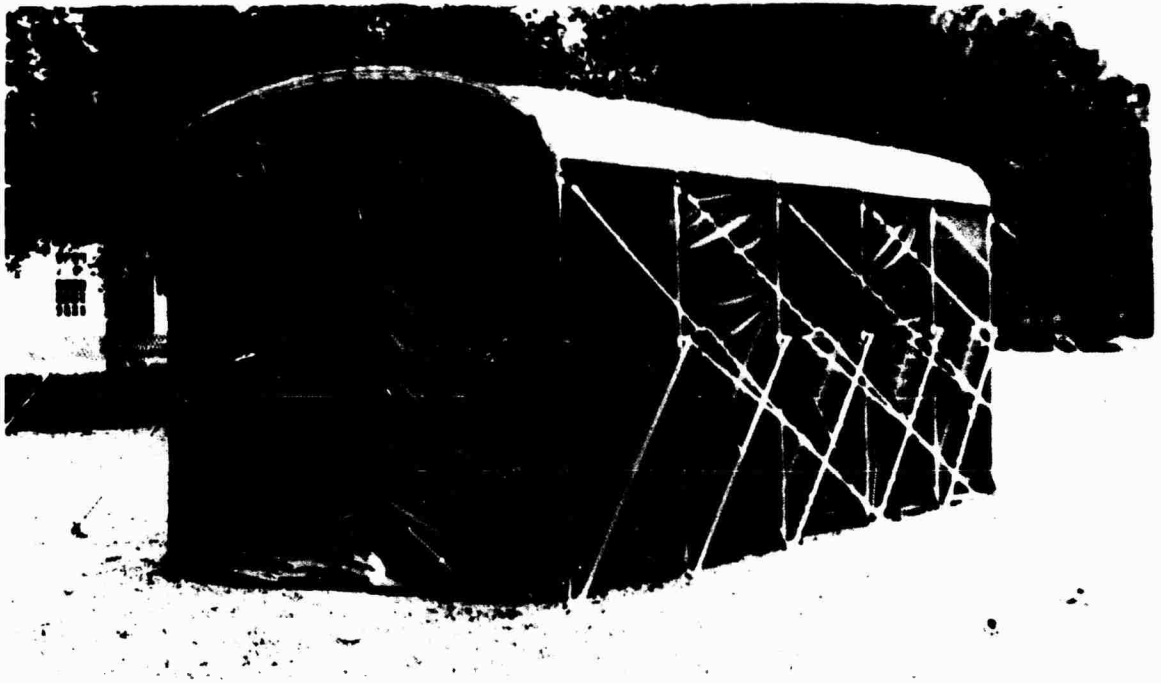
28. Be adaptable to installation of NBC collective protection equipment.

29. Be constructed of materials of non-toxic nature which contain no elements which would cause dermatitis or complicate wounds.

30. Have instructional material permanently affixed to the shelter indicating the proper method of erection, use, maintenance, striking and repacking.

31. Be provided with kits to make the shelter extendible in height to 18 feet as required.

32. Be provided with a repair kit--one for each shelter.

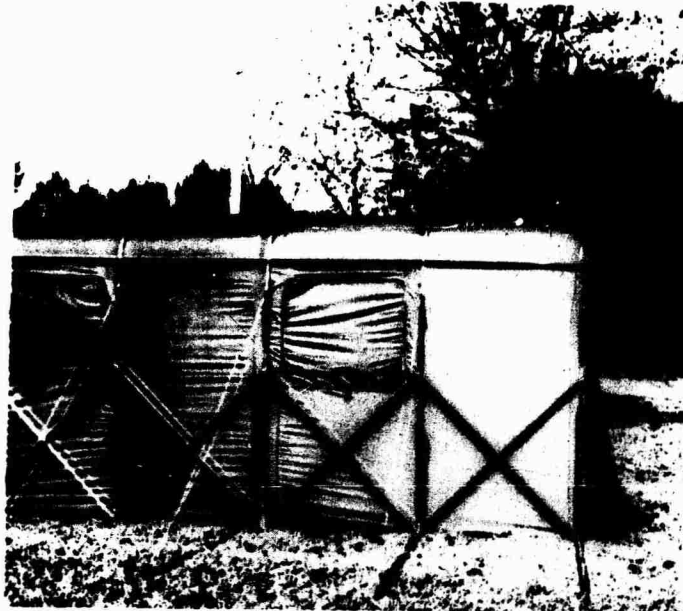


Side View With End Closed

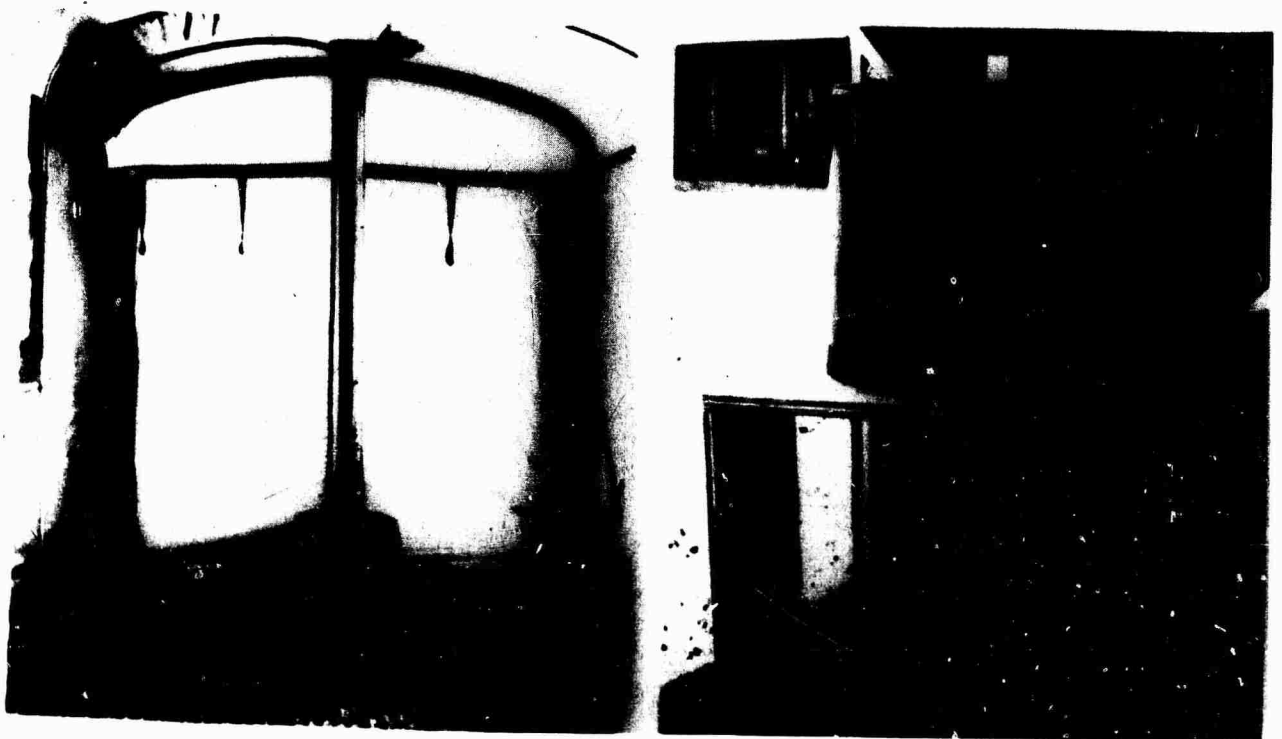


Side View With End Open

ANNEX B - Experimental Shelter, Extendible, Small, Accordion Type, Erected



Side View Showing Location of Space Heater Stack



Interior View Showing Location of Space Heater Location of Oil Supply Can For Space Heater

ANNEX B - Experimental Shelter, Extendible, Small, Accordion Type, Erected

## APPENDIX C

### DEFICIENCIES AND SUGGESTED MODIFICATIONS

1. The hasps and staples for holding the bows in the open position should be strengthened: the staples bend easily when forced.
2. An opaque fabric is desirable for blackout purposes: present test item (at NMFRL) does not have blackout integrity.
3. The slip-joints on the bows can be functionally improved by allowing more clearance: the present joints tend to stick or jam, particularly after the shelter has been erected for a considerable length of time.
4. The roof of the present test item tends to acquire pockets of water as a result of rain. However, this does not present a real problem. Prevention of these pockets would require a steeper roof or a more taut fabric, either of which would detract from the utility of the shelter.
5. The steel pegs for anchoring the shelter should be more ruggedly constructed: when firmly embedded in the earth, they tend to bend and the guy line hooks tend to break when the pegs are forcibly extracted.
6. The Velcro fasteners used for holding the covers over the windows deteriorate when exposed to sunlight and other atmospheric conditions. The Velcro fasteners should be replaced with heavy-duty zippers.
7. Specially designed insert screens should be provided for the ends of the shelter to protect the inhabitants from insects and to provide adequate ventilation. These screens can be attached to the fabric which composes the ends of the shelter or attached by means of snaps to the end bows.
8. An attic-type exhaust fan mounted near the roof of one end of the shelter would be helpful for providing forced ventilation.
9. Means should be provided for insulating the interior of the shelter against environmental weather conditions (heat and cold). This could be accomplished by utilizing a satisfactory shelter liner.



10. The test item requires a clear, level area for proper erection, and therefore, is less desirable for use in rough terrain than the standard M-1945 Command Post Tent.

11. No instructional material is affixed to the test item. Instructional material should be permanently affixed to the item indicating the proper method of erection, use, maintenance, striking and packing.

12. No repair kit was furnished with the test item. At least one repair kit should be furnished with each item.

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13. ABSTRACT		
<p>A small extendible, accordion-type shelter was tested to determine its ventilation and heating characteristics, effects on the human body, insectproofing capability, and suitability for use as a medical and dental field shelter. (U)</p> <p>The test item, Shelter, Extendible, Small, Accordion-Type, was tested at the request of the Marine Corps Landing Force Development Center, Quantico, Va. The item is fabricated from nylon and aluminum. When erected, it measures 8 feet high by 8 feet wide by 20 feet long and when contained in its carrying case, it measures approximately 8 feet by 13 inches by 28 inches and weighs 171 pounds. The item was erected and exposed for 10 months to the climatic conditions occurring at Camp Lejeune, N. C. During this exposure period, tests were conducted to determine the characteristics mentioned in the above paragraph. (U)</p> <p>Results of the tests indicated that in its present design the test item has no adverse effect on the human body, can be adequately heated and ventilated when not blacked out, can be insectproofed, and can be satisfactorily utilized as a battalion aid station shelter by Fleet Marine Force medical organizations. However, its structural framework is less durable than shelters presently in use and the cover material is not light-proof. (U)</p> <p>It was concluded that the deficiencies listed in this report should be corrected before the test item is considered for adoption as a standard stock item. (U)</p>		

**KEY WORDS:**

**Shelter**

**Extendible shelter**

**Accordion-type shelter**

**Field shelter**